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NATIVE ANDEAN FOOD PLANTS[1]

Melvin L. Bristol[2]

Solutions to the increasingly critical problem of world food shortages are being sought most vigorously and with the greatest hopes of success by increasing the productivity of the world's major food crops.

Our major food stuffs are derived from 25-30 species of cultivated plants, yet it is common knowledge that many hundreds of other species also yield highly acceptable and nutritious foods. Although a gigantic and many-faceted effort to increase the world food supplies has long been underway, relatively very little attention has been devoted to species which are not already of major importance. It is imperative that we become informed of the present status and future potential of ALL energy-yielding, cultivated, food plants. For a surprising number of these species, there is little, or often no reliable taxonomic, genetic, physiologic, agronomic, or economic information available.

In the New World, a large number of food-producing cultigens has evolved from the indigenous flora. Several---maize, potato, cassava and others---were catapulted to great international importance during the sixteenth and seventeenth centuries. Many others, however, are cultivated over no greater geographical area than in 1500 A.D. The reasons for this are complex, and with little information in hand, they remain elusive. In several cases photoperiodism is involved.

About half of all New World cultigens have evolved along the western fringe of South America, in the massive and environmentally extremely diverse Andean Cordillera. Table I lists the indigenous cultivated food plants, excluding "fruits", of this region, and indicates the extent of varietal diversification.

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[1] In part, a lecture presented at the April 4, 1966 meeting of the Hawaiian Botanical Society.

[2] Visiting Assistant Professor of Botany (Spring Semester 1966), University of Hawaii.

Table I. Indigenous Andean Cultivated Food Plants (Excluding Fruits).

Common Name	Species	Family	Approx. No. Andean Cultivars
Tubers:			
Potato	**Solanum tuberosum* L., sensu Dodds	Solanaceae	150+
Oca	*Oxalis tuberosa* Mol.	Oxalidaceae	50
Olloco	*Ullucus tuberosus* Cald.	Basellaceae	10
Mashua	*Tropaeolum tuberosum* R. & P.	Tropaeolaceae	10
Achira	**Canna edulis* Ker	Cannaceae	5
Roots:			
Arracacha	*Arracacia xanthorrhiza* Bancr.	Umbelliferae	20
Yacon	*Polymnia sonchifolia* P. & E.	Compositae	1
Maca	*Lepidium meyenii* Walp.	Cruciferae	<5
Ahipa	*Pachyrrhizus ahipa* (Wedd.) Parodi	Leguminosae	<5
Seeds:			
Common bean	**Phaseolus vulgaris* L.	Leguminosae	100+
Lima bean	**P. lunatus* L., *P. flavescens* Piper	Leguminosae	?
Lupine	*Lupinus mutabilis* Sweet	Leguminosae	<5
Poroto	*Erythrina edulis* Tr.	Leguminosae	?
Quinoa	*Chenopodium quinoa* Willd.	Chenopodiaceae	40
Canihua	*C. pallidicaule* Aellen	Chemopodiaceae	5
Amaranth	**Amaranthus caudatus* L.	Amaranthaceae	<5
Vegetables:			
Quinoa	*Chenopodium* spp.	Chenopodiaceae	?
Squash	**Cucurbita moschata* Poir.	Cucurbitaceae	?
Squash	**C. maxima* Duch.	Cucurbitaceae	?
Squash	**C. ficifolia* Bouché	Cucurbitaceae	?
Achoccha	*Cyclanthera pedata* Schr.	Cucurbitaceae	?
Huacamuyu	*Philoglossa peruviana* DC.	Compositae	1

* Cultivation no longer confined to the Andean region.

For most of the plants listed, the greatest need is a critical assessment of intraspecific variability and a workable classification of the cultivars. Upon such a basis, a comprehensive evaluation of the merits of the less known food plants can proceed in confidence. A broadly based, rational consideration of world food supplies requires such information.

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BROMELS IN HAWAII[1]

Amy Jean Gilmartin[2]

Introduction

Scattered about the Hawaiian Islands are bromel growers who by one means or another have acquired seeds or plants of a typical tropical American plant family, the Bromeliaceae. This monocot family has about 2,000 species. Briefly, some of the easily recognizable characteristics are: a rosette of leaves, often forming a cup or tank, with each leaf varying from strap-shaped to narrowly triangular or linear; a stalk-formed inflorescence, although the stalk or scape may be so short that the flowers appear to form in the center of the rosette; and flowers that are usually regular, although some have a zygomorphic corolla.

Often the species which are propagated for gardens have colored floral bracts and frequently colored leaves, such as solid red, purple mottled, or red and green striped or mottled. The leaf surface especially is conspicuous for the presence of the scales, stalked peltate appendages, up to 0.4 mm in diameter. These may be very apparent to the naked eye because of their abundance and the color they give to the leaf. The scales have been called "trichompomps" by early German workers because of the role they play in the absorption of surface water into the intercellular air spaces of the leaf (Mez, 1904). More than half of the members of the family are epiphytes.

The desirability of bromels as garden and house plants is apparent to anyone who has acquired one. Some can be grown successfully in a cactus and succulent garden, while others flourish in moist habitats. Foster (1953) and Wilson & Wilson (1963) describe some of the ways they can be made effective garden plants. The colorful vegetative parts make the plants attractive even when not in flower, and the amount of care necessary to raise them is minimal. Germination from seed is very easy and requires no special treatment other than planting them as soon as possible after they are mature. Vegetative propagation is easier and much quicker than seed germination. By taking offshoots one may have a new flowering plant within a year, while with seed germination the time lapse is at least several years for most bromels. Many methods of germinating seeds have been described as well as methods of growing from offshoots (Downs & Piringer, 1958; Moir & Moir, 1956). Most of these methods are so simple that anyone can carry them out with a minimum of effort and no special equipment.

Distribution, Natural and Man Affected:

The plant family, Bromeliaceae, is largely restricted to the Americas. Species are found growing wild from the Southeastern United States to Uruguay and Chile. The center of distribution seems to be central and northern South America (Smith, 1934). There are about 13 species with distributions which include the Southern United States. Whether or not any of these species which now grow naturally in the southern continental United States have been established as a result of the activities of man cannot be verified. It does seem likely that the majority, and certainly the genus Hechtia (subfamily Pitcairnioideae) which is present in Texas, has been dispersed without the intervention of man.

There is no doubt that all the bromel species currently found in Hawaii have been introduced purposely by man, including, of course, the pineapple (Ananas comosus (L.) Merrill). In Hawaii the "center of distribution" of bromels, excluding the pineapple,

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[1] The financial assistance of the Distribution Committee, McInerny Foundation is gratefully acknowledged for a grant which made possible a collecting trip in August 1965 to Ecuador, to complement earlier collections with living material.

[2] Graduate student, Department of Botany, University of Hawaii. Her doctoral dissertation research topic is, "The Bromeliaceae of Ecuador, an Alpha Taxonomic and Taximetric Study".

might be said to be Nuuanu valley. About 119 different species grow at the Honolulu Foster Botanic Gardens and about 100 at the home of W. W. G. Moir. The origin of these introductions is not always clear, although there are some that are documented. In addition to the estimate of over 100 species in Nuuanu Valley, there are nearly 200 at the Manoa Valley nursery of Howard Yamamoto. The Pineapple Research Institute has about nine different species, all members of the subfamilies, Pitcairnioideae and Bromelioideae, growing in its patio. These and the several other species at their Wahiawa field station are the descendents of the Collins and Baker expedition (Central America and Brazil in the 1930's) introductions. A drive through some residential areas of Honolulu will yield a view of a bromel now and then. Most frequently noticed are Gravisia and Aechmea, both spiny-leaved with leaves often turning red after flowering. Bromels are sometimes found on sale in a few Honolulu garden shops.

On the Big Island Mrs. A. Lester Marks has a number of bromels growing at about 250 meters elevation on the slopes above Kailua-Kona. According to Mr. Yamamoto, these are flourishing in a remarkable way. Although many are the same species that are growing in Honolulu, the effect is much more stunning. Even near Hawaii Volcanoes National Park, there are a few cultivated bromels. Several are growing at the Chester A. Wentworth home at about 1100 meters altitude.

It is probably only a matter of time before serious growers of bromels begin to ship plants to the mainland in some bulk. Recently, a San Diego nursery has been enquiring about the possibility of raising bromels in Hawaii. Current plans of the organization call for purchase of land on Oahu where lath houses will be built for growing ornamentals including bromels. Initially bromel offshoots will be brought in and maintained in the private nursery's own State-inspected greenhouses. Apparently there is a greater demand for bromels in California than can be supplied there, and nursery plans to ship new offshoots to the mainland following the postentry quarantine period.

It is not established whether or not there are any escapes of bromels growing naturally in Hawaii. The author is unaware of any observations of bromel escapes in Hawaii, with the possible exception of the "Spanish moss" (Tillandsia usneoides (L.) L.). This may establish itself relatively easily in new areas (Garth, 1964).

Introduction of Bromel Seeds to Maui:

A collecting trip to Ecuador in August 1965 was undertaken to obtain additional bromel herbarium specimens and live plants. Fruits of 36 species were obtained. Of these, seed from 21 have been successfully germinated and are growing at Kula, Maui under the supervision of the Superintendent of the Maui Branch of the Hawaii Agricultural Experiment Station, Dr. David Williams. The seeds were planted in several lots on hapuu chips starting on September 27 and ending December 1, 1965. At the present time they are 0.5 to 2 cm. tall with from three to nine leaves. When they are 2-3 cm. in height, they will be transferred. A field study on phenotypic variation relative to different rainfall patterns will be initiated. In addition a pilot laboratory experiment will be undertaken for investigation of the relative effects and possible interaction of moisture and light. The seeds from Ecuador are from various species found from near sea level to 3,300 meters. However, none will be planted at altitudes as high as this on Maui. The "Massenerhebung Effect" which results in the lowering of altitudinal limits on isolated mountains relative to large mountain masses, prescribes a much lower altitude for Maui to correspond with a high altitude from continental Ecuador. Richards (1964), Bear (1944), and Eyre (1963) mention this effect in regard to Central American and Malaysian isolated mountains.

Apparently no way has yet been defined to predict what the changes in altitudinal vegetation limits may be between any two given areas. This is particularly the case when one area is a continental mountain mass, and the other is an isolated mountain mass. On Maui Williams (1966, personal communication) found that plants which grow at Nairobi at about 2100 meters, are successful at Kula, Maui at about 700 meters. The author's observations of the Galapagos Islands mountains and the Andes of Ecuador indicates that the type of forest present on the continent at about 2200 meters is found on the Galapagos at approximately 700 meters. Perhaps the "Massenerhebung Effect" deserves more attention than it has received, and especially so by biogeographers. Certainly it merits as much attention as the latitude and altitude interaction effect on plant distribution.

Difficulties Involved in Bringing Live Plants into Hawaii:

One of the most difficult of plant families for obtaining entry into the State of Hawaii is the family Bromeliaceae. It is permissible to bring live plants into the state if one can obtain a permit.[3] Certain conditions are prescribed in the issued permit for Bromeliaceous species. These are regulated by Regulation no. 1.2, which became effective on August 14, 1947.[4] The plants are fumigated in a vacuum chamber with methyl bromide. Following the treatment, they are subject to postentry quarantine and must be kept in a screened room with double entry doors for at least one year, and for a longer period if the State Plant Inspectors suspect that any plant pests or diseases are still present. Chances of plant survival may be increased if the plants arrive on a week day. If they are treated upon arrival and then taken to the screened room and washed immediately, more individuals are likely to survive. If they arrive on a weekend, the additional delay can lower the survival rate of the plants. It behooves the bromel exporter to pack his plants free of soil and in ventilated containers. Another hurdle for successful bromel importation is survival from infection of the fungus Phytophthora after they arrive in Hawaii. There are two or three species in the Islands which produce rot of the plant from the inside out, especially during rainy periods. To help alleviate this problem, the plants should be sprayed about every month with the fungicide "Dexon", which is available locally.

Fortunately, there is an easier way to import bromels. Bromel seeds from foreign areas can be imported with much less trouble than live plants. After inspection[5] by the Federal Plant Quarantine Inspectors, they are subject to surveillance at the request of the State Plant Quarantine Office. Also it is fortunate that seeds of bromels apparently do not carry diseases. The Plant Pathology Department Head of the Pineapple Research Institute, Dr. E. J. Anderson, told me, "There is no evidence yet that any virus or fungus disease is carried in pineapple seed." He seems to feel that this could also be applied to other bromeliaceous plants.

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[3] Ed. Note: Application for permits may be made to the Chief Plant Inspector, Plant Quarantine Branch, State of Hawaii Department of Agriculture, P. O. Box 2520, Honolulu 96804. Permits are issued for a limited number of plants. "Such permits however, will only be issued when the advisability of such introduction has been determined from the standpoint of the pineapple industry and the horticulture of Hawaii as a whole." (Sec. 2, Part 2, Reg. 1.2).

[4] Ed. Note: The introductory paragraph of this regulation reads as follows: "The Board of Commissioners of Agriculture and Forestry, having determined that there exists serious danger to the pineapple industry of Hawaii from the introduction of thrips (Franklinella moultoni Hood, Franklinella shultzei Trybom), pineapple borers (Anomocaulus fulvovesticus Fuern., Metamasius spp., Thecla basiliodes) and such other insect and other pests and diseases of pineapple and other bromeliaceous plants as are not now established in Hawaii, hereby adopts the following Regulation with the purpose and intent to prevent by its enforcement the introduction of such insect and other pests and diseases."
Other regulations promulgated by the State, regulate the importation of plant hosts which could affect major agricultural crops or important ornamental plants, such as sugar cane and grasses, coffee, certain vegetables, orchids, bananas, passion fruit.

[5] Ed. Note: Application for a permit to import propagative material from foreign sources into Hawaii may be made by writing to the Plant Quarantine Division, Agricultural Research Service, U. S. Department of Agriculture, P. O. Box 340, Honolulu 96809.

Relative Merits of Introduction of Exotics into Hawaii:

There are many proponents for introducing exotic plants into the Islands. Yet there is the other side of the coin. The Hawaiian flora would be a remarkable workshop for botanists today if all the plant introductions did not exist. There are those who say that now is the time to stop introducing new plants. However, the author feels that the economy of Hawaii being what it is, and the position of the islands as a transportation hub in the Pacific make it futile to try to keep out plants just to maintain the native flora. Sadly, maintenance of the Hawaiian biota is a losing battle which can only be fought now on limited areas, such as National Parks. While agreeing wholeheartedly with the concept of taking care in choosing introductions that will be suitable and taking care to comply with the rules of the State of Hawaii Agricultural Department, the author feels that the bromels are a worthwhile introduction. It is true that if they continue to grow here and if more are brought in that eventually some escapes would probably become established. Perhaps this is justifiable and even desirable. At least, the bromels are aesthetically pleasing and they are not likely to usurp the places of the other epiphytes such as the ferns and Bryophytes. These all often grow together in tropical America.

If one grants the desirability of bringing bromels to Hawaii, there is still the responsibility incumbent upon the introducer to document and record the plant introductions. If all original plant introductions were always recorded, the job for future botanists and horticulturists would be much easier. With the increased travel of man this becomes not only a good idea, but a real necessity. Fortunately, foreign plant introductions are automatically recorded to some degree when they pass through the Federal Plant Quarantine Division. The USDA inspectors send a report listing the plants inspected to the State Plant Inspection Office. If the exact name is not known, however, the inspector may merely write a brief description, such as "Cacti from Peru." This is no help at all to the botanists of the future. Therefore, it behooves the plant introducer to somehow put on record his introduction: the exact locality where the plants were obtained; the identification to the best of his ability, at least as to family; and the locality where they will be grown in Hawaii.

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ECOLOGY OF CITRUS IN JAPAN[1]

Robert M. Warner [2]

An increasingly important crop in Japan is Citrus. In 1963 the Ministry of Agriculture anf Forestry reported 272,836 acres in cultivation and forecasted by 1971, 454,826 acres (1). Production in 1963, 1.28 million short tons of fruit was expected to reach by 1971, 2.81 million tons. By comparison, the California acreage is reported to be 245,000 acres and Florida about 500,000 acres.

The "Satsuma mandarin" (Citrus unshiu Marc.) which was discovered about 300 years ago in southern Kyushu, makes up over 81% of the acreage (1957) and 83.6% of the production (1). The Satsuma is a high quality, loose-skinned fruit having a red-orange rind, very similar to some of our tangerines. It is medium in size and completely seedless when grown unmixed with other Citrus species. The crop ripens in November and December. An early strain, the "Waseunshiu," matures fruit in October and November. The "Natsudaidai" or "Japanese summer grapefruit" (C. natsudaidai Hayata) makes up 13% of the citrus acreage and about 11% of the total production. It matures in June when fresh "Satsumas" are no longer available. Of less importance are the "Hassaku" (C. hassaku Hort. ex Tanaka) which has some characteristics of the "pummelo" and the "Washington navel orange" (C. sinensis Osbeck). They represent 1.4 and 1.0% of the citrus acreage, respectively (1).

The islands of Japan form a long arc from northeast to southwest and are separated from the Asian continent by the Sea of Japan. Their nearness to the continent results in cold dry winds from the northwest in winter and hot humid winds from the southeast (Pacific side) in summer. Heavy rainstorms and sometimes typhoons occur in September. There is usually a hot dry period in summer, but rainfall is adequate for citrus growing on the south and east sides of the islands of Honshu, Shikoku and Kyushu, but not on the coast of the Seto Inland Sea, where irrigation is practiced.

The annual rainfall in Japan ranges from 47 to 118 inches. This variation is related to the mountainous topography. The "backbone" of mountains which runs through these islands reduces rainfall on the northwest side until November, when the winds off the Sea of Japan bring moisture. On the Pacific side rainfall reported at Okitsu, Shizuoka prefecture, may be typical. Here the average rainfall is 11 or 12 inches in June and September but only about 3 inches in December and January. The total annual rainfall is about 85-90 inches.

The most important factor influencing the distribution of citrus acreage in Japan is temperature. The commercial citrus plantings south of Tokyo (36 N latitude) are within 12 miles of the Sea where winter temperatures are moderated by the warm water brought up from the tropics by the "black current." In Shizuoka prefecture, the northernmost of the important producing areas, *Citrus* is not planted above 1,500 foot elevation. At Okitsu, which is near sea level, the mean minimum temperature for January and February is in the mid-30's and the extreme minimum is 18 F. Until recently, the level paddy fields were preempted for rice and vegetables. Now some *Citrus* is being planted on these fields. Special protection from low temperature and from dry winter winds are needed. Covers of rough rice straw mats or netting are used. To help protect the leaves from dehydration, oil sprays are applied in December.

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[1] This paper was made possible by the writer's participation in the East-West Center sponsored Field Training and Interchange in Citriculture in Japan (November 1965) with support from the University of Hawaii and the Hawaii Agricultural Experiment Station. In part, a lecture presented at the February 7, 1966 meeting of the Hawaiian Botanical Society.

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Also very important is the use of "Trifoliate" rootstock (*Poncirus trifoliata* (L.) Raf.), which is resistant to cold. Ninety per cent of the "Satsumas" in Japan are grafted on "Trifoliate orange" rootstock. "Trifoliate" is a *Citrus* relative which becomes dormant and sheds its leaves in winter. *Citrus* grafted on "trifoliate" tends to become more cold tolerant.

"Trifoliate" has other valuable attributes such as resistance to soil fungal diseases such as gumnosis and foot rot, and to the quick decline virus, Tristeza. In addition, the "trifoliate" rootstock appears to improve the quality of oranges and tangerines grafted on it more than any other rootstock. "Trifoliate" is, however, susceptible to the exocortis virus which is transmitted from infected plants by grafting. It is also subject to chlorosis on alkaline soils (above pH 7).

In some low fields cold air drainage occurs on still nights, and the "Natsudaidai" is planted instead of the "Satsuma" because it is more tolerant to frost.

Wind protection is provided in most districts for the growing trees. Windbreaks are planted as soon as an orchard is planned. *Podocarpus macrophylla* D. Don is the most commonly used tree, although *Cryptomeria japonica* D. Don is used in the Maana district of Ehime prefecture (Shikoku). Both trees can be trained to tall slender growth and the root competition with the *Citrus* trees is not too serious.

Slopes protected from typhoon winds are preferred for the shallow-rooted *Citrus*. Judicious pruning keeps the trees below 6 to 10 feet in height. Established trees on the shallow-rooted "trifoliate" root are frequently inarched at the ground level with the deep-rooted "yuzu" (*Citrus junos* Sieb. ex Tanaka) to give them better anchorage and extend the life of the trees. In the Arami district of Wakayama prefecture, the topography protects the plantings so well that windbreaks have not been necessary.

In the Miyahara district near Wakayama, defoliation of the *Citrus* was observed as a result of salts blown in from the sea by the two separate typhoons in September, 1965.

Most of the *Citrus* orchards are planted on slopes. More than 41% are on slopes of more than 15 degrees and of these, 4% are on slopes of more than 30 degrees (1). Terraces, many constructed of stone, are a necessity. This makes cultural practices more difficult and expensive in terms of labor.

The soil depth on these slopes is only six to eight inches. Many years of cultivation and the incident of erosion and leaching have reduced its natural fertility. To compensate for these losses, large amounts of chemical fertilizer are applied. Approximately 300 pounds of nitrogen, 180 pounds of phosphate, and 240 pounds of potash per acre per year are applied to adult trees. In some soils magnesium and lime are applied. Zinc, manganese, boron, and molybdenum are applied as foliar sprays.

Because of the danger of erosion, cultivation has been reduced to about once a year and grass cover is encouraged. Mulches of rice straw are widely used around young trees for weed control, to reduce erosion and to conserve moisture.

Close planting is practiced to obtain high yields in the young orchards with 800-1000 trees being planted per acre, as compared to about 100-200 trees in the U.S.A. Trees tend to be smaller on "trifoliate" rootstock but the presence of exorcortis and other viruses may account for much of this.

Diseases such as scab, citrus canker, and melanose, and insect pests such as arrowhead scale, citrus red mite, citrus rust mite, white flies, leaf rollers, leaf minors and aphids are controlled by sprays. Six to eight spray applications are needed per year. Many districts have the spray liquids piped to the terraces in plastic tubing from cooperative mixing and pumping stations which are located above the terraces.

Citrus canker, a bacterial disease to which the "Satsuma" is fairly resistant, is widespread in Japan. To protect the American citrus industry from citrus canker, the importation of the high quality Japanes Satsuma to the U.S.A. is prohibited except in processed forms.

The citrus fruit is harvested in boxes which are sent down the terraces by cables and conveyers to collecting points lower on the slopes. From there, three-wheeled trucks take the boxes of fruit down surfaced roads to cooperative packing and processing plants. The cooperatives are vital to the efficient production, harvesting, and marketing of citrus in Japan because of the small size of the plantings. The average owner or operator has less than one acre.

The distribution of citrus in range compared to other major crops in southern Japan is noteworthy. Deciduous trees such as the "persimmon," (Diospyros kaki L. f.) and the "chestnut," (Castanea crenata Sieb. & Zucc.) are found at higher elevations and extend further north than Citrus (2). In Shizuoka prefecture, tea, (Thea sinensis L.), an evergreen shrub, is grown near Citrus and at higher, cooler elevations. Rice and vegetables, paddy field crops which are found growing near Citrus in the south, grow north of Tokyo beyond the low temperature tolerance of Citrus. Small plantings of the mulberry, (Morus alba), for silk worm culture are present in citrus districts of Shizuoka prefecture. The common fig, (Ficus carica), was observed as home garden trees at lower elevations in Wakayama and Ehime prefectures.

The "Satsuma mandarin" grafted on the trifoliate orange rootstock appears to be well adapted to the climate and soils of southern Japan. Temperature was found to be the most important factor influencing its distribution in Japan.

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THE SHOOT APICAL MERISTEM

WITH EMPHASIS ON RECENT EXPERIMENTAL STUDIES[1]

Clifford W. Smith[2]

The apical meristem or the terminal growing point of the shoot is the region in which cell division and organ formation take place in the primary stem of higher plants. This ultimate tip of the shoot is generally dome-shaped and surrounded by leaves in various stages of development. The leaves are formed from the apex and are produced in a determinate sequence, generally a spiral. From the position of the previously formed leaves, one can predict the position of future leaves. The cells in this region are generally small, with dense cytoplasm and small vacuoles.

Though many theories have been proposed concerning the organization of the apical meristem, the most generally accepted description, at present, is of a small pocket of cells at the extreme apex which divide infrequently in the vegetative apex. During the transition of the vegetative apex into the reproductive state, however, these cells divide rapidly and remain active in the floral apex. Under these terminal cells is a region from which the bulk of the stem tissue is derived. At the side of these terminal cells is a region in which very active cell division takes place, and it is in this region that the leaves first appear on the surface of the meristem. The structure has been partly confirmed by histochemical studies and techniques using radioactive isotopes. The position of active cell division was localized by using the synthesis of DNA as a measure of the activity of the replicating nuclei.

Wardlaw and his co-workers (1963), in a series of experiments on the fern, Dryopteris dilatata, isolated the young leaf primordia or that area of the meristem in which the next primordia would be formed. They came to the following conclusions:

(i) Normally all lateral primordia develop as leaves, but when isolated by a surgical incision from the surrounding tissues they can form either a leaf or a bud.

(ii) The determination of a primordium as a leaf coincides approximately with the formation of an enlarged apical cell on the leaf primordium.

(iii) As mentioned above, it is possible to determine the position of the next leaf primordium to be formed. If this area of the apical meristem is isolated, then a bud is produced and not a leaf. It was suggested that the outgrowth of the primordium was necessary for the determination of the primordium as a leaf.

(iv) The apical meristem controls the development of the primordium as a leaf. It is conducted through the embryonic vascular tissue beneath the leaf primodium.

Steeves and Sussex (1961) confirmed the results of Wardlaw when they found that when the excised leaf primordia of Osmunda cinnamomea were grown in vitro, the young leaf primordia grew into new plants while the older primordia developed as leaves. They also found that with low concentrations of sucrose the excised leaf developed as a juvenile form. By increasing the percentage of sucrose, larger and more mature leaves were formed and some of these ultimately produced sporangia.

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[1] In part, a lecture presented at the May 2, 1966 meeting of the Hawaiian Botanical Society.

[2] Visiting Assistant Professor of Botany (Spring Semester 1966), University of Hawaii.

In Angiosperms, the determination of a primordium as a leaf is effected before the primordium becomes apparent. If the apical meristem is removed, however, the incipient and youngest primordia have been reported to form buds rather than leaves.

Since the beginning of the century botanists have been trying to grow the isolated apical meristem of Angiosperms in sterile nutrient media. Loo (1945) obtained the continued growth of the isolated shoot tip of Asparagus in vitro without the formation of roots on a simple synthetic medium. Ball (1946) grew the isolated apical bud of Lupinus and Tropaeolum on a relatively simple medium. He noted that the basal tissues underwent a considerable anatomical change before growth of the apex was resumed. There are many other later reports of the successful growth of isolated apical buds of Dicotyledons but very few of Monocotyledons. Ball (1960) partially succeeded in growing the isolated apical meristem of Lupinus, but after producing five new leaf primordia, the apex ceased growing.

In vitro techniques have many disadvantages, particularly the tendency of the actively growing explant to initiate roots. Smith (1965) in studies on the growth of excised embryo shoot apices of wheat found that once the explant had rooted the effect of substances added to the culture medium were different than when roots were not initiated. Also on excision, the wounded tissues and several layers of cells beneath showed signs of necrosis and other aberrant growth responses. It is difficult to estimate the effect of these cells on the remainder of the explant. There is also a considerable time lapse between the excision of the apical tissue and the resumption of growth, but if roots are formed the growth response is immediate. The effects of roots on shoot growth, other than the absorption of nutrients and water, have not been fully determined. Smith (1965) has suggested that in wheat, the roots may synthesize gibberellins which are necessary for the continued growth of the shoot.

There are practical applications of culturing isolated apices. Carnation specialists use isolated shoot tips of carnations to obtain virus-free stocks, and orchid growers use a modification of this technique as a means of large-scale vegetative propagation of certain varieties.

Though the mechanism of action of the flowering stimulus is not known, the morphological, anatomical, and physiological developments have been studied in considerable detail. In general, when the shoot apex changes from the vegetative to the reproductive condition, the growth of that apex is determinate. An exception to this can be found in the pineapple. Though the whole sequence of floral organs of ultimately differing morphology are produced in a short space of time, there is considerable argument as to the homology of these lateral organs. Tepfer (1953) has suggested that they are homologous, though Meeuse (1966) has summarised evidence against this homology.

In experiments where the shoot apex was excised and then induced to flower, or had already been induced to flower, indoleacetic acid (IAA) was critically important in the control of the growth of the stamen and carpel. Heslop-Harrison (1957) suggested that though controlling the determination of individual floral members in the early life of the primordium, the concentration of auxin also determined the balance of growth between the male and the female organs. Raghavan and Jacobs (1961) have found that IAA was necessary for the continued growth of the sporogenous tissues while suggesting that other hormones, particularly the gibberellins, were also important.

In conclusion, the apical meristem in shoots is a difficult organ to study experimentally, mainly due to its small size and extreme delicacy. In the culture studies carried out so far, most responses are not evident for a considerable time after inoculation. This tends to make one sceptical of the results. The obvious changes in the basal tissues also emphasize cautious interpretation. Although the apical meristem is thought to control the organogeny of the shoot, how much of the 'apex' is involved in this process is difficult to establish. Experimental studies have shown us little of the potential of the apical meristem, and the old idea that the cells of this organ are totipotent needs qualification. They are totipotent when the organ is *in situ* or when the culture medium contains the correct balance of nutrients and hormones. Ball (1960) has suggested that the apical meristem of Angiosperms has undergone biochemical differentiation, and that some of the functions have been taken over by the adjacent tissues. However, though a little is known of the function and properties of the shoot apical meristem, much further research is still necessary.

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PINEAPPLE RESEARCH INSTITUTE

In an effort to save money, the Trustees of the Pineapple Research Institute of Hawaii announced in April that the operation of their research facility will be reduced from the present staff of 68 to 23 by June 1, 1967. Also involved is the removal of the Institute's operations from the present site, adjacent to the University of Hawaii, to the Wahiawa field station.

It became very apparent early in the history of the pineapple as a crop in Hawaii, that in order to turn and increase profits, scientists would have to be employed as an integral part of the industry. Large scale packing operations had begun in 1903 when 1,800 cases were produced at the J. B. Dole Cannery. In 1914 the Hawaiian Sugar Planters' Association set up a Pineapple Division to handle the problems which had arisen during the early years of commercial production. By 1923 the Association of Hawaiian Pineapple Canners had established a field experiment station. This facility must be considered, strictly speaking, the first PRI. Later the Dole Street complex was initiated near land formerly planted with the first Smooth Cayenne by John Kidwell in 1886.

About 1930 the young Institute successfully met the first major challenge to the industry when the problem of wilt disease threatened to ruin the crop. Since that time the testing and application of insecticides, combined with numerous innovations in planting and cultivating, have resulted in a much increased production efficiency. Soil testing, application of fertilizers, development of fumigants, and the use of hormones have not only controlled the major pest - nematodes, but also have resulted in an ever more profitable crop. The use of a series of herbicides began in 1946 and proved a boon to efficient and economic production. In recent years emphasis on trace elements and new varieties, combined with biochemical and physiological investigations, have contributed to making the pineapple a more desirable consumer product. Much of the research in recent years has been aimed at the possible expansion of the fresh pack market on the mainland and new field potential outside of Hawaii. By 1966 virtually every step in the production of pineapple as well as the characteristics of the fruit have been modified and improved in some way through the efforts of PRI scientists and staffers.

Since the PRI is solely industry supported and was set up "to perform fundamental and applied research for the members (of the AHPC) and the protection of the pineapple industry," much of the work of the Institute has had a limited circulation. Over the years, however, the PRI staff has produced scores of basic and applied science contributions, many of which have appeared in various technical journals. Many staff members have been closely involved in national and international scientific organizations as well as making worthwhile local community and scientific contributions, including serving as Affiliate Graduate Faculty members at the University of Hawaii. It is impossible to estimate the collective impact of the Institute and its staff, past and present, on the scientific and economic life of Hawaii. This contribution cannot be fully measured in terms of the value of the current pack alone.

The reduced PRI program will include research in plant breeding and nematology. With the pineapple fast becoming more of an internationally grown and consumed crop every year, there are those who predict that the present deemphasis of local research in such areas as physiology and soils, entomology, pathology, chemistry and biochemistry, is only a short pause in a distinguished and economically profitable history of industry supported research.

COLIN POTTER, 1906 - 1966

Colin Potter, who was for thirty years the Resident Superintendent of the Foster Botanic Garden, died in Hilo on May 3, 1966. He was born in Onomea, Hawaii, and graduated from Punahou School. Mr. Potter worked as an Assistant in Botany for the Experiment Station of the Hawaiian Sugar Planters' Association under Dr. Harold L. Lyon. He was associated with the Foster Garden since 1931 when Mrs. Mary Foster gave her home adjoining the HSPA Experiment Station's Forest Nursery to the city of Honolulu. At that time the city purchased the Forest Nursery where Mr. Potter had been employed, and the result was a public botanical park - Foster Garden.

In addition to innumerable contributions to the preservation and growth of Foster Garden, he was known for his successful breeding of ornamental varieties of "ti". Notable among his introductions was the variety, "Peter Buck". During early years failing eyesight made work difficult. He was a long-time member of the Botanical Society. Our deepest sympathy goes to Mrs. Nora Bush Potter of Volcano, Hawaii, in her loss.

A more detailed article about Colin Potter will be written by Dr. Yoneo Sagawa of the Department of Horticulture, University of Hawaii, and will appear in the Orchid Society Bulletin.

E. E. SHERFF, 1866 - 1966

Dr. Earl Edward Sherff, born in Flint, Michigan, May 18, 1866, died on May 16, 1966 in Hastings, Michigan. He graduated from Albion College and the University of Chicago, where he earned the S. M., and Ph.D. degrees, *magna cum laude*. In 1923 he became Instructor in Botany at Chicago Teachers College, and from 1929 until his retirement in 1951, Head of the Department of Science.

Though he never visited the far-distant Hawaiian Islands due to his devotion to his invalid son residing at home in Michigan, Dr. Sherff monographed much of the native and endemic flora of this remarkable archipelago. The genera treated are *Aleurites*, *Alsinodendron*, *Antidesma*, *Bidens*, *Cheirodendron*, *Claoxylon*, *Dodonaea*, *Drypetes*, *Dubautia*, *Euphorbia* s.l., *Gnaphalium*, *Haplostachys*, *Labordia*, *Lagenophora*, *Lipochaeta*, *Munroidendron*, *Nototrichium*, *Phyllanthus*, *Phyllostegia*, *Pittosporum*, *Platydesma*, *Railliardia*, *Rauvolfia*, *Remya*, *Reynoldsia*, *Schiedea*, *Sesbania*, *Silene*, *Stenogyne*, *Tetramolopium*, *Tetraplasandra*, and *Xylosma*. This is an astounding accomplishment for any man. But, in addition to concentrating on elements in the Hawaiian flora, this erudite scholar monographed the huge genus *Bidens* for the World, and produced numerous taxonomic papers on genera besides those listed above.

The magnificent collections borrowed from the Marie C. Neal Herbarium of the B. P. Bishop Museum was of fundamental aid for his research which was conducted in his office in the Field Museum in Chicago. Many critical specimens, however, were never made available to him during his early studies and hence remain to plague, with provisional or no species identifications, Honolulu workers. B. P. Bishop Museum Directors A. Spoehr and R. W. Force, however, liberalized loan requirements and thus gained hundreds of hours of expert work *gratis* on genera monographed by Sherff during their more enlightened administrations.

Mrs. Sherff and son Miner survive. (Otto & Isa Degener)

NEWS AND NOTES*

HAWAIIAN BOTANICAL GARDENS FOUNDATION, INC. (CEH): The Trustees of the Foundation announced the granting of a financial award to Dr. Melvin L. Bristol, Curator of Collections, Harold L. Lyon Arboretum, University of Hawaii. At the regular meeting on May 11, the Trustees voted to appropriate the sum of $1,200 for Bristol's forthcoming study of the tree Daturas in South America. He will be in the field from September to October, working in Ecuador, Peru, and Bolivia. In September he will present a paper at the "Symposium on Ethnobotany in the Americas," in Buenos Aires, Argentina.

PLANT QUARANTINE DIVISION, ARS, USDA (ETT): Plant Quarantine Inspector John L. Wuotila left for his new duty station at Travis Air Force Base, California, on June 2. He has been at the Port of Honolulu for nine and one-half years. His last assignment in the port was at the Barber's Point Naval Air Station. He wrote a key to the identification of conifers most frequently encountered in plant quarantine work, which was published as a USDA Plant Quarantine Memorandum in 1963. The port of Honolulu and the Division owe him thanks for the fine collection of colored slides of exotic fruits and flowers which he made for training purposes.

Alvin K. Chock received a letter of appreciation and a cash award of $100 for his proposal of a postentry quarantine for Chrysanthemum propagative plant material.

John C. Frey, Assistant to the Director for Management, PQD, Hyattsville, Maryland, and Kenneth L. Maehler, Pacific Regional Supervisor, San Francisco, arrive on June 18 for a supervisory visit to the port of Honolulu. Another visitor expected in Honolulu in late June, but on vacation, is Dr. Harold S. Shirakawa, Assistant in Charge, PQD Training Center, New York. He and his family will spend most of their time in Hawaii on the island of Kauai.

UNIVERSITY OF HAWAII:

Department of Botany (NPK): Dr. Gladys E. Baker, Professor of Botany, attended the annual meeting of the American Society for Microbiology in Los Angeles May 1-5. She had a particular interest in the session on medical mycology.

On April 24, Dr. A. C. Smith, G. P. Wilder Professor of Botany, left for a two month visit to the mainland and Brazil. In addition to continuing his research at the Smithsonian Institution, he will attend three meetings, including one at Belem, Brazil. There he will address a symposium on "Amazon Biota," organized by the Association for Tropical Biology.

Dr. Maxwell S. Doty, Professor of Botany, presented a paper at the Second International Oceanographic Congress. He was at Moscow, Russia, from May 30 to June 13. He then spends two weeks in Europe visiting various scientific institutions. He will be joined in Singapore and Manila by Lester Hair, Head of the Biology Department, Reedley College, San Joaquin Valley, California. They will conduct ecological and morphological studies of Caulerpa and Eucheuma. Dr. Doty then goes to Tokyo for the 11th Pacific Science Congress where he will present wo papers.

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* Prepared by the Assistant Editor, Shinya Namiki, through the cooperation of the News Representatives of the Newsletter.

Two courses will be offered by the Department during the summer session. "Identification of Tropical Plants" (Botany S160), will be taught by Alvin K. Chock, Lecturer in Botany, and USDA Plant Quarantine Inspector; and "Plant Life of the Sea" (Botany S181), by Dr. Michael Neushul, Jr., Associate Professor of Botany, University of California at Santa Barbara.

Department of General Science: Dr. Albert J. Bernatowicz, Professor of General Science, received the Board of Regents award for "excellence in teaching." He teaches two sections of Science 120-121, "Introduction to Science," which has an enrollment of 1400 students per semester. A phycologist, he was first a member of the Department of Botany. He is presently Chairman of the Department of General Science.

Extension Service (YN): A trip to Okinawa was made in early June by Dr. A. A. LaPlante, Associate Specialist in Entomology, CES; Yukio Nakagawa, Associate Specialist in Horticulture, CES; and Dr. Mamoru Ishii, Associate Plant Pathologist, HAES. They are travelling under the auspices of the US Army, in connection with a contract that the College of Agriculture has with the Army to help the agricultural program in the Ryukyus.

Harold L. Lyon Arboretum (GWG): Dr. Melvin L. Bristol has been appointed Curator of Collections at the Arboretum. This appointment becomes effective on July 1. He will continue his research on tree Daturas and tropical economic plants, and supervise the collections at the Arboretum. He came to Hawaii in January from Harvard University, and was Visiting Assistant Professor of Botany during the spring semester.

BISHOP MUSEUM: Dr. and Mrs. Harold St. John left Honolulu on June 4 for the mainland to visit their children and to attend various meetings. Dr. St. John, Museum Botanist and Professor Emeritus of Botany, UH, will present papers at the 11th Pacific Science Congress in Tokyo. In the fall the St. Johns will be in Florence, Italy, where he will continue his monographic research on Pandanus at the Instituto Botanico. During the past year he has been the Acting Curator of the Herbarium.

ELEVENTH PACIFIC SCIENCE CONGRESS (AKC): The 11th PSC convenes for a period of three weeks from August 22 at the University of Tokyo and other places in Japan. A "Circular of Information" about the Congress may be obtained from the Science Council of Japan, Ueno Park, Tokyo, Japan. Three charter Japan Air Lines flights are being sponsored by the Hawaiian Academy of Science, with the round trip cost from HAS members being $294. It is our understanding that some space is still available on these flights, but only to thos who have been Academy members for at least six months prior to the trip.

DEGENERS: The Otto Degeners are spending a "quiet" summer on the island of Hawaii, near the Hawaii Volcanoes National Park. They plan to work on a revised edition of "Plants of Hawaii National Park," which was published in 1930 and reprinted in 1946.

BOT SOC NOTES*

ISSEC Science Fair (GEB): Terry Mau of Haiku School, Maui, was given the Society's Intermediate Division Award for his project, "Root growth of legume plants". Honorable Mention went to Laura Nishiyama of Kula Elementary School, Maui, for "Post-harvest control of carnation heads". No award was given in the Senior Division. There were fewer exhibits this year, but the students had more elaborate displays. Society judges were Dr. Gladys E. Baker, Professor of Botany, UH, and Miss Beatrice Krauss, Plant Physiologist, PRI.

Foster Garden Education Building (DM-D): In reply to a letter written by the President, Mr. Fed T. Johnson, Director of the Dept. of Parks & Recreation, City & County of Honolulu, stated that the present emphasis of the Department is the development of existing undeveloped parks, and not the improvement of developed ones. In a separate communication, he stated that part of the Kapiolani Hibiscus Garden will be changed to a flower garden, with annuals to be changed four times a year.

Society Award to UH Senior (NPK, in part): There was no student qualified to receive the Outstanding Botany Student Award this year. Present standards for the award include having had 20 units in Botany, of which three may be in any plant science or genetics, and a 3.5 grade point average in these courses by a senior at the UH, were not changed this year. The Executive Committee will, however, present recommendations for next year. The award presently consists of a one year membership in the Hawaiian Botanical Society and the Botanical Society of America, plus the engraving of the student's name on a plaque in the Department of Botany.

Bananas (SF): Dr. Adrian Brash, Honolulu dentist, who has a large plot of land devoted to the propagation of different banana varieties, spent an evening on Sam Fisk's program answering questions on bananas until the wee hours of 4 a.m. Dr. Brash is especially interested in those varieties which were developed by the prehistoric Hawaiians, and has spent much of his free time hiking in the mountains to collect propagative material.

Plant Raffle: The semi-annual plant raffle to receive donations for the refreshment ("Aloha Hour") was conducted at the April Meeting by Bob Warner and Mahesh Upadhya. Aloha Hour hostesses this year have been: Remy Hartmann and Lucy Espiritu (Jan.); Mrs. Babcock and Mrs. Lauchis (Feb.); Mrs. Oscar Kirsch, Mrs. Smith, and Mrs. Babcock (Mar.); Mrs. M. S. Doty and Mrs. Richard Smith (Apr.); Mrs. D. Mueller-Dombois (May), and Mrs. N. P. Kefford (June).

New Members (RW): Dr. Clifford Smith and Dr. Melvin L. Bristol, Department of Botany, UH; Fairchild Tropical Garden, Miami, Florida (exchange); Dr. Walter J. Apt, PRI; Mrs. Flora Rice, 2969 Kalakaua Ave., Honolulu, Dr. Richard P. Haynes, 45-430 Akimala St., Kaneohe; Paul Yamanaka, 2116 Lime St., Honolulu; Lewis Cooksey, P. O. Box 100, Kunia; Suraphong Kosiyachinda, Dept. of Horticulture, UH; and William S. Null, Research

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* Abstracted from the Minutes of the Society Meetings by the Secretary, Dr. Richard W. Hartmann. (AKC).

Forester, Forestry Division, State of Hawaii.

Address change: Dr. Jacques F. Barrau, Laboratoire d'Ethnobotanique, Museum National d'Histoire Naturelle, 57 Rue Cuvier, Paris 5, France.

Society Speakers: (April) "Native Andean Food Plants," Dr. Melvin L. Bristol, Visiting Assistant Professor of Botany, UH; (May) "The Shoot Apical Meristem with Emphasis on Recent Experimental Studies," Dr. Clifford W. Smith, Visiting Assistant Professor of Botany, UH; (June) "Plants, Climate, and Phytotronics - The Use of Controlled Environment Facilities for the Analysis of Plants' Responses to Climate," Dr. Noel P. Kefford, Professor and Chairman, Department of Botany, UH.

Next Meeting: There will be no regular monthly meeting until Monday, October 3. The speaker on that date will be Dr. Haruyuki Kamemoto, Professor of Horticulture, UH, who gave his tentative topic as "Orchids in Thailand".

The field trip, however, will be held on Monday, July 4.

FIELD TRIPS

Society Summer Field Trip on Oahu:

Destination: Manoa Cliff Trail

Date & Time: Monday, July 4 (holiday), 9 a.m.

Meeting Place: Experiment Station, HSPA, 1527 Keeaumoku St., Honolulu.

The trip will start from the above designated place. Mr. Tom McGuire, retired Territorial Forester, will lead the excursion, and will be assisted by Drs. Adrian Brash and Dan Palmer. Transportation to the trail should be provided by those going on the trip. Since the trip will end at approximately 2-3 p.m., pack lunches should be brought by the participants.

For further information, call Dr. Daniel D. Palmer, telephones 997-568 (office) and 966-083 (residence). This will be the only printed announcement of the trip.

Suggested preparatory reading: Fosberg, F. R. (editor). 1961. Guide to Excursion III. Tenth Pacific Science Congress.

Hawaii Volcanoes National Park Trip:

Destination: Hawaii Volcanoes National Park

Date & Time: Tuesday, July 5, 9 a.m.

Meeting Place: Hilo Airport Terminal, Hilo.

A field trip to Hawaii Volcanoes National Park, sponsored by the National Science Foundation for a group of high school teachers will take place on July 5, beginning at the designated place above and ending at approximately 5:00-5:30 p.m. on the same day at the airport. There will be about eight free spaces available on a chartered bus.

Society members interested in participating are cordially invited. Please notify Dr. Dieter Mueller-Dombois, c/o Hawaii Volcanoes National Park Headquarters, Volcano, Hawaii 96718, of your intention to participate. The trip will be designed to emphasize the relationships between climate vegetation and soil, and also aspects of invation and succession of vegetation on new volcanic materials. Dr. Vladimir J. Krajina, Professor of Botany, University of British Columbia, and Honorary Associate in Botany, B. P. Bishop Museum, will collaborate on this excursion. (DM-D).

DUES

There are at the present time fifty members who have not paid their dues for the current calendar year. Sending out dues notices involves both time and money, and your cooperation is solicited if you have not paid your dues yet. Please remit your dues (3.00 for regular members and $2.00 for student members) to:

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